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The impact of interpersonal closeness cues in text-based healthcare chatbots on attachment bond and the desire to continue interacting: an experimental design

Kowatsch, Tobias ; Nißen, Marcia K ; Rüegger, Dominik ; Stieger, Mirjam Nadine ; Flückiger, Christoph ; Allemand, Mathias ; von Wangenheim, Florian

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THE IMPACT OF INTERPERSONAL CLOSENESS CUES IN TEXT-BASED HEALTHCARE CHATBOTS ON ATTACHMENT BOND AND THE DESIRE TO CONTINUE INTERACTING: AN EXPERIMENTAL DESIGN

Research in Progress

Kowatsch, Tobias, University of St.Gallen, St.Gallen, Switzerland, tobias.kowatsch@unisg.ch

Nißen, Marcia, ETH Zurich, Zurich, Switzerland, mnissen@ethz.ch

Rüegger, Dominik, ETH Zurich, Zurich, Switzerland, drueegger@ethz.ch

Stieger, Mirjam, University of Zurich, Zurich, Switzerland, m.stieger@psychologie.uzh.ch

Flückiger, Christoph, University of Zurich, Zurich, Switzerland,
christoph.flueckiger@psychologie.uzh.ch

Allemand, Mathias, University of Zurich, Zurich, Switzerland,
m.allemand@psychologie.uzh.ch

von Wangenheim, Florian, ETH Zurich, Zurich, Switzerland, fwangenheim@ethz.ch

Abstract

Working alliance describes an important relationship quality between health professionals and patients and is robustly linked to treatment success. However, due to limited resources of health professionals, working alliance cannot always be promoted just-in-time in a ubiquitous fashion. To address this scalability problem, we investigate the direct effect of interpersonal closeness cues of text-based healthcare chatbots (THCBs) on attachment bond from the working alliance construct and the indirect effect on the desire to continue interacting with THCBs. The underlying research model and hypotheses are informed by counselling psychology and research on conversational agents. In order to investigate the hypothesized effects, we first develop a THCB codebook with 12 design dimensions on interpersonal closeness cues that are categorized into visual cues (i.e. avatar), verbal cues (i.e. greetings, address, jargon, T-V-distinction), quasi-nonverbal cues (i.e. emoticons) and relational cues (i.e. small talk, self-disclosure, empathy, humor, meta-relational talk and continuity). In a second step, four distinct THCB designs are developed along the continuum of interpersonal closeness (i.e. institutional-like, expert-like, peer-like and myself-like THCBs) and a corresponding study design for an interactive THCB-based online experiment is presented to test our hypotheses. We conclude this work-in-progress by outlining our future work.

Keywords: Counselling Psychology, Working Alliance, Human-Computer Interaction, Chatbot, Interpersonal Closeness.

1 Introduction

Working alliance is a key construct in the therapeutic process and robustly linked to treatment success (Flückiger et al., 2012; Horvath and Greenberg, 1989; Martin et al., 2000). Working alliance reflects the degree to which health professionals and patients interact with each other in order to achieve an attachment bond and a shared understanding about therapeutic goals and tasks (Castonguay et al., 2006). In more detail, attachment bond can be expressed as liking, trusting, or a feeling of common purpose and understanding between a health professional and patient (Horvath and Greenberg, 1989). By contrast, therapeutic goals are the desired distal outcomes of a treatment (e.g. reducing 10kg of body weight over the course of six months). Therapeutic tasks are derived from these goals and represent activities that are agreed upon between health professionals and patients and that target the proximal outcomes of a treatment (e.g. daily diet behaviour, physical activity and stress management).

Due to limited personnel and financial resources of health professionals (Aluttis et al., 2014; Wahle et al., 2017; Wahle et al., 2016), the development of a mature and sustainable working alliance and its three dimensions is so far restricted to personal encounters in face-to-face consultations (Constantino et al., 2002) or remote care settings (Ronis et al., 2017).

Against this background, there is an increasing interest in technology-based self-service channels (Scherer et al., 2015) and digital health interventions (DHIs), i.e. health information systems that support patients in their everyday life and which could help strengthening working alliance over the course of a treatment (Agarwal et al., 2010; Jacobs et al., 2016; Klasnja et al., 2015; Marsch et al., 2014; Morrison et al., 2012; Nahum-Shani et al., 2015; Nahum-Shani et al., 2016; Plaete et al., 2016; Ryan et al., 2017; Silva et al., 2015; Young et al., 2017). Especially, DHIs delivered via text-based messaging services, for example, as offered by Florence (<http://getflorence.co.uk>) or lark.com are characterized by conversational turns similar to dialogs in on-site counselling sessions and thus, seem to be appropriate to support the working alliance between health professionals and patients (Beun et al., 2017; Bickmore et al., 2010b). Text messaging services are also “cheap, fast, democratic and popular” (Herring, 2004) and, especially for young people, the preferred way of communication (Smith and Page, 2015).

We are therefore interested in the design of effective text-based healthcare chatbots (THCBs), i.e. scalable conversational computer agents that support health professionals in the delivery of evidence-based health interventions in a ubiquitous and scalable fashion via conversational turns with the goal to increase working alliance by communicating therapeutic goals and tasks in an empathetic way. Albeit the large interest in DHIs, it is remarkable that, to the best of our knowledge, there is no literature stream that investigates working alliance with respect to design characteristics of THCBs. We thus start with this work to identify effective THCB designs by tackling attachment bond first, i.e. the emotional dimension of the working alliance construct as defined above (Horvath and Greenberg, 1989).

In this work, we see THCBs as extensions of health professionals that support patients in their everyday life and formulate the two following two research questions (RQs):

(RQ1) Which design characteristics of THCBs are positively related with attachment bond?

(RQ2) Is attachment bond positively related with the desire to interact continuously with a THCB?

While an answer to the first research question will help academics and practitioners to design empathic THCBs, an answer to the second question would be important as an ongoing interaction with a THCB represents a prerequisite to build a shared understanding about therapeutic goals and tasks, which are, in turn, the two remaining dimensions of a sustainable working alliance. Especially in the context of chronic diseases such as asthma or diabetes where DHIs are usually designed to last for several years it is still open how to design corresponding engaging THCBs.

The remainder of this work-in-progress is structured as follows. We next outline related work and present the research model including our hypotheses. Thereafter, we outline the method used to assess the hypotheses. That is, we first present a codebook for THCBs that describes characteristics for THCB designs which we hypothesize to directly increase attachment bond and indirectly the desire to continue interacting with a THCB. Second, we outline an online experiment that is designed to assess four particular THCB designs empirically. An outlook on future work concludes this work-in-progress.

2 Related Work

Chatbots are text-based conversational agents, i.e. computer programs with a conversational user interface capable to emulate natural, conversational interpersonal exchange (Cassell et al., 2000). They can be integrated into familiar instant messaging services (e.g. Google's conversational agent is implemented in the mobile messaging app Allo) or implemented in desktop applications or websites and are available for various self-service purposes.

Accordingly, there exist already various conversational assistants and chatbots such as Amazon's Alexa, Apple's Siri, Aldebaran & Softbank Robotics's Pepper, Google's Assistant, IBM's Watson for Oncology, Microsoft's Cortana or Samsung's Bixby (Ebling, 2016). However, most of them cannot be applied in a medical context due to their lack of rigorous healthcare knowledge (Miner et al., 2016).

Therefore, dedicated conversational agents with a health focus like Buoy Health (www.buoy-health.com), Florence (getflorence.co.uk), koko (itskoko.com), Lark (www.web.lark.com) or Molly (sensely.com) and various other messaging services, have recently gained interest in academia and industry with both inconclusive (Kiluk et al., 2014) and promising results related to user acceptance (Bickmore et al., 2010b), working alliance (Bickmore et al., 2005) and treatment success (Cottrell et al., 2012; Haug et al., 2017).

These inconclusive findings may be due to a lack of understanding of what individuals need when interacting with conversational agents and how to design these agents accordingly (McTear et al., 2016; Shechtman and Horowitz, 2003). Moreover, it is clear that the design of conversational agents requires justificatory knowledge from various scientific fields such as human-computer interaction (Bickmore et al., 2010a; Ring et al., 2012), computational linguistics (Andrews et al., 2006; Mairesse et al., 2007; Migneault et al., 2006; Walker et al., 1997), sociolinguistics (Kacewicz et al., 2014; Tausczik and Pennebaker, 2010). And when it comes to the application of conversational agents in the healthcare context, justificatory knowledge from psychotherapy (Flückiger et al., 2012) or motivational interviewing (Bickmore et al., 2011; Miller and Rose, 2011), just to give two examples, is required, too.

Across all these disciplines, researchers are suggesting that conversational agents need to adopt the characteristics of human-human interaction in order to be more engaging (Derrick et al., 2011; Elkins et al., 2012). To this end, human-computer interaction researchers have started to study how users react to anthropomorphic characteristics of conversational agents (Ochs et al., 2017) and how such cues affect the behavior of individuals (Lee and Choi, 2017).

Backed by the *computers as social actors* theorem by Reeves and Nass (1996) stating that individuals apply similar patterns and heuristics of social interactions with other individuals when interacting with computers, longitudinal studies on relationship-building embodied conversational agents indicate promising results (Bickmore et al., 2005; Bickmore et al., 2010c; Provoost et al., 2017). However, these embodied conversational agents, i.e. agents that convey visual attributes similar to human beings such as hand gestures and facial expression, are not easy to implement and adapt to various application domains. They often still require a larger desktop-based interface instead of a small mobile and ubiquitous interface provided by today's smartphones to convey their visual expressions and thus, to support the underlying verbal cues and content that is communicated.

Against this background and in line with Sundar (2008) stating that "[...] often simple text-based computer-mediated communication (CMC) is far more effective than visually resplendent CMC [...]", we aim to contribute to the development of less complex conversational agents that can rely on minimal sets of verbal and social cues mainly determined by their text-based communication channel. As our work has its focus on the delivery of digital health interventions with the help of this type of conversational agents, we call them text-based healthcare chatbots (THCBs).

Due to the fact that empirical evidence of the impact of THCBs on treatment success is still sparse (e.g. Haug et al., 2017), we are interested in how to design THCBs that support patients in their everyday life and therapeutic settings beyond on-site consultations as described further in the next section of this work-in-progress.

3 Research Model and Hypotheses

Figure 1 shows the research model and hypotheses of the current work. It also includes constructs and relationships in dotted lines that indicate our future work and an overall picture. The rationale for the research model and the corresponding hypotheses are provided in the following paragraphs.

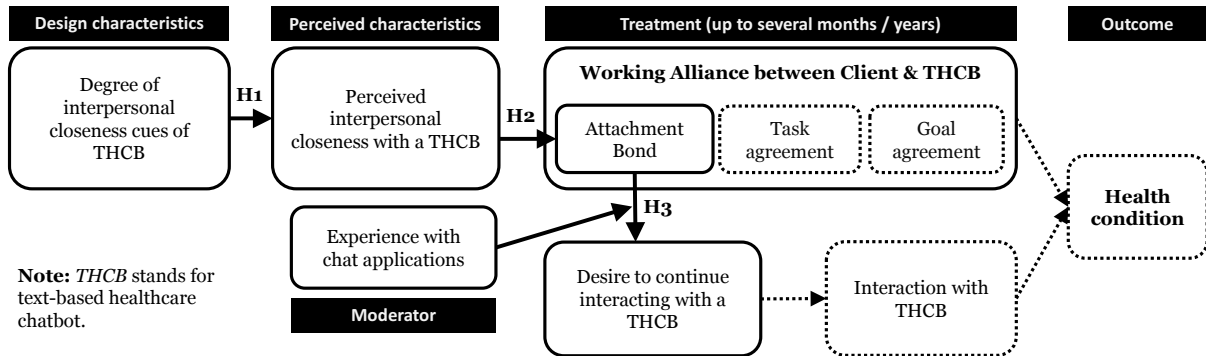


Figure 1. Research model.

The basic assumption underlying our research model is derived from counselling psychology that indicates a robust link between working alliance and treatment success as outlined in the introduction (Flückiger et al., 2012; Horvath and Greenberg, 1989), i.e. the upper right part of the research model. In our work, we apply working alliance with its three dimensions attachment bond, task agreement and goal agreement, as a relationship quality construct between patients and health professionals that employ THCBs to improve treatment outcomes.

By contrast, a second stream of research indicates that the frequency of interactions between health professionals and patients is linked to treatment outcomes (Kawaguchi et al., 2013; Lombard et al., 1995), i.e. the lower part of the research model. Without these on-going interactions, treatment goals and tasks cannot be communicated, too. We are therefore also interested in the impact of the working alliance construct, in particular attachment bond as the focus of the current work, on the desire and actual behaviour to continue interacting with THCBs (i.e. direct effects) and treatment outcomes (i.e. indirect effects), i.e. the health condition of patients.

Within the context of this overall research model, we focus now on the first research question of the current work and introduce perceived interpersonal closeness as a predictor of attachment bond. Perceived interpersonal closeness is a measure of

structure (who), function/strength (how much) and realization of closeness needs with an unlimited number of significant others. In clinical practice, it could be used to assess total and specific provision of closeness (e.g. under-provision, over-provision, enmeshment, marital discord) and availability of social support and relevant changes. (Popovic et al., 2003, p. 298)

We argue that patients may also perceive a sense of interpersonal closeness with a THCB. The rationale of this assumption is informed by the work of Reeves and Nass (1996), who showed that people behave towards media just as they behave towards other people, which is also known as *the media equation*. This finding could be replicated in several other studies since then (e.g. Bickmore and Cassell, 2005; Lisetti et al., 2013; Picard, 1997; Zhao et al., 2016). Moreover, interpersonal closeness cues represent intimacy, familiarity, closeness, solidarity or affiliation between two social actors (Aron et al., 1992; Gächter et al., 2015; Popovic et al., 2003; Spencer-Oatey, 1996) and thus, could be also used to derive corresponding design characteristics for THCBs. Based on the assumption that perceived interpersonal closeness is reflected in the use of language (Svennevig, 1999), there is also evidence that a social linguistic model for interpersonally close conversational agents is positively linked to users' perceptions of an agent's knowledgeableness and ability to engage with users (Cassell and Bickmore, 2003). Similarly, we assume that the degree of interpersonal closeness cues embedded into the design of THCBs,

for example, via linguistic and visual anthropomorphic cues, will increase an individual's perceived interpersonal closeness with a THCB. We thus formulate our first hypothesis:

H1: *The degree of interpersonal closeness cues in a THCB has a positive relationship with a patient's perceived interpersonal closeness with that THCB.*

Second and in line with findings outlined above on the media equation and the relational design characteristics of embodied conversational agents in a longitudinal therapeutic setting (Bickmore et al., 2005), we assume that higher perceptions of interpersonal closeness with a THCB will also increase attachment bond between a THCB and patient. We therefore formulate our second hypothesis as follows:

H2: *Perceived interpersonal closeness with a THCB has a positive relationship with attachment bond between THCB and patient.*

Finally, it has been already shown that attachment bond is related to the desire to continue interacting with embodied conversational agents (Bickmore et al., 2005; Bickmore and Picard, 2005). That work employed a social distance measure and encoded different degrees of relational language into a relational vs. non-relational conversational agent. The authors found positive effects on study participants' attachment bond and a higher desire to continue interacting with the relational agent compared to a non-relational version. This is consistent with IS research as (1) satisfaction with an IT artifact is positively linked with information systems continuance intentions (Bhattacharjee, 2001) and (2) perceived enjoyment is positively linked with the intention to return or (re)use an IS artefact (Kamis et al., 2008; van der Heijden, 2004). Moreover, IS research on technology acceptance and use (Venkatesh et al., 2003; Venkatesh et al., 2012) indicates that experience with an IT artifact, in our case experience with chat applications such as Facebook Messenger, WhatsApp, iMessage or Telegram, moderates usage intentions. We thus formulate our third and final hypothesis in the THCB context as follows:

H3: *Experience with chat applications positively moderates the positive relationship of attachment bond between THCB and patient and the desire of a patient to continue interacting with that THCB.*

4 Method

To investigate the direct effect of perceived interpersonal closeness on attachment bond and the indirect effect on the desire to continue interacting with THCBs, we developed a codebook for different THCB designs along the continuum of interpersonal closeness from low to high. After outlining the development of these THCB designs, we describe an online experiment with the objective to assess the manipulation of interpersonal closeness perceptions and to test our three hypotheses.

4.1 Interpersonal Closeness Codebook for THCB Designs

As a prerequisite to empirically assess our hypotheses, a codebook for THCB designs needs to be developed along an interpersonal closeness continuum. We thus explicitly searched for studies that investigated effects of distinct levels of interpersonal closeness on study outcomes (Bickmore et al., 2005; Sah and Peng, 2015; Verlinde et al., 2012; Zhao et al., 2014; Zhao and Cassell, 2016). For example, previous studies investigating anthropomorphic cues, have contrasted visual cues with linguistic cues (Sah and Peng, 2015) or relational vs. non-relational behavior (Bickmore et al., 2005). Moreover, studies on embodied conversational agents studied *nonverbal* relational cues such as eyebrow raises or head movements (Bickmore et al., 2005). We then employed the evolving framework on interpersonal relations in conversations (Svennevig, 1999) which implies that friendships or romantic loves would be more personal relationships, while acquaintances would be less personal. The THCB designs were eventually created on an axis ranging from rather impersonal (institutional-like and expert-like) to personal (a peer-like and a myself-like). Against this literature work, we differentiate visual, verbal, quasi-nonverbal and relational cues that allow for the development of clearly distinctive communication styles for each THCB design. The final codebook resulting from our literature work is shown in Table 1 while examples of the communication styles and visual cues of four particular THCB designs are shown in Figure 2. Details on the rationale of the identified cues are provided in the following four paragraphs:

Visual cues (see Nowak and Rauh, 2005; Sah and Peng, 2015). As our THCBs will operate in a text-messaging setting, we decided they would need a simple and small graphical representation like in WhatsApp, Apple's iMessage or Facebook's Messenger. We used avatarmaker.com to design the avatars, which made it possible to alter age, gender and accessories (e.g. glasses, clothes) to make them look more professionally- or ordinary-looking. In the myself-like condition of the online experiment outlined below, participants will have the chance to either upload a photo of themselves or to use a default representation of a human-resembling silhouette.

Verbal cues. Walker et al. (1997) emphasized the importance of linguistic style as key aspect for the creation of artificial agents. We thus adapted our set of verbal cues from prior work (Bickmore et al., 2005) and manipulated interpersonal closeness verbally by altering greetings with regards to their degree of politeness and formality, by modulating the form of address and control for use of professional jargon, which will be higher for the institutional- and expert-like THCB designs. As the first online experiment will be conducted in German-speaking countries we also make use of different forms of address with regard to the T- and V-forms (Levinson, 1983).






Characteristic	Institution	Expert	Peer	Myself
Interpersonal closeness	Low 			High
Visual cues				
Avatar (Nowak and Rauh, 2005; Sah and Peng, 2015)	 Institutional logo	 Avatar of an older, more professionally-looking person	 Avatar of a more ordinary-looking person	 Real photo of the patient
Verbal cues				
Greetings (Cassell and Bickmore, 2003; Laver, 1981)	Formal	Formal	Informal	Informal
Address (Laver, 1981)	Non-specific	Professional	First name	First name
Jargon (Vosbergen et al., 2015)	Professional	Professional	No, colloquial	No, colloquial
T-V-distinction (German) (Levinson, 1983)	Sie	Sie	Du	Ich (Wir)
Quasi-nonverbal cues				
Emoticons (Walther and D'Addario, 2001)	No	No	Yes	Yes
Relational cues				
Small talk (Bickmore and Cassell, 2005)	No	Few, once a week	Frequently, every day	Frequently, every day
Self-disclosure (Moon, 2000)	No	No	Yes	Yes
Empathy (Boukricha and Wachsmuth; Klein et al., 2002; Lisetti et al., 2013)	No	No	Yes	Yes
Humor (Morkes et al., 1999)	No	No	Yes	Yes
Meta-relational talk (Bickmore and Schulman, 2012)	No	No	Yes	Yes
Continuity (Gilbertson et al., 1998)	No	Few, once a week	Frequently, every day	Frequently, every day

Table 1. Codebook for THCBs designs on interpersonal closeness

Quasi-nonverbal cues (see Walther and D'Addario, 2001). Following research on the impact of emoticons, i.e. icons displaying emotions also known as emojis, we decided that the peer-like and myself-like THCB designs should make use of them.

Relational cues (see Bickmore and Picard, 2005). With regard to the interpersonal closeness gradient, linguistic strategies of THCBs can be assumed to be different, i.e. by their use of empathy, self-disclosure, humor, meta talk (talk about the relationship itself), and continuity talk.

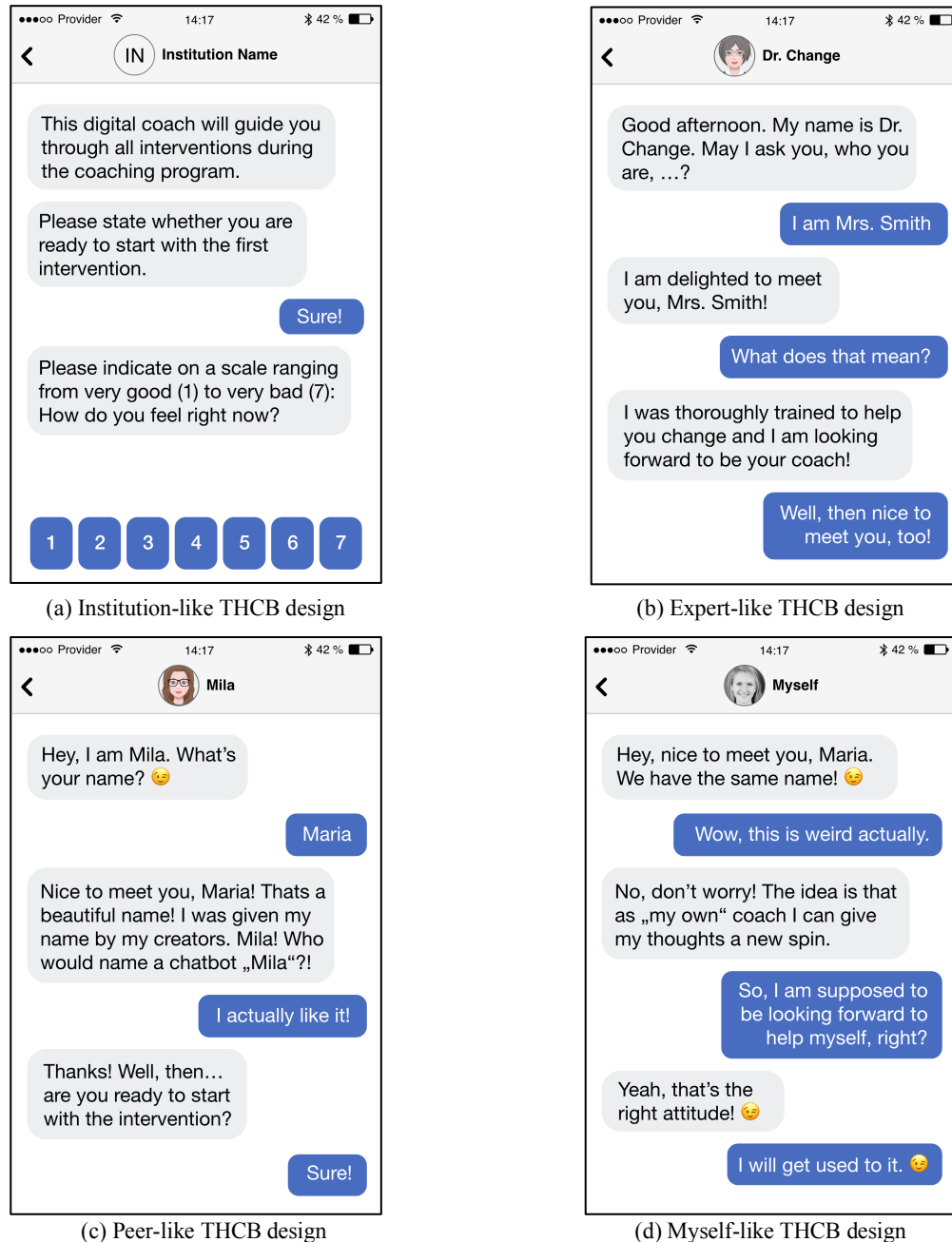


Figure 2. Exemplary excerpts of conversational turns of the four THCB designs

4.2 Design of an Online Experiment

To assess our hypotheses, we plan to conduct an online experiment, in which subjects will randomly interact with one of the four THCBs described in the last subsection. In line with Lisetti et al. (2012) and due to mixed evidence of cross-gender effects on chatbot perceptions (Hannon, 2016; Hone, 2006;

Karacora et al., 2012; Lee, 2004; Schulman and Bickmore, 2009; Zambaka et al., 2006), subjects will be randomly assigned to female or male graphic representations of the *expert-like* and *peer-like* THCB designs. Additionally, participants of the study older than 40 years will see a graphical representation of the peer-like persona that looks older than the one displayed to subjects younger than 40.

The experiment is separated into several parts. First, subjects are asked to assess a THCB that was built by [name of experts] of the psychological department of [name of university] to help potential clients to work on their personality. All THCBs are thus tied to one institution which counterbalances any potential side effects related to different origins or aspects of institutional trust such as reputation (Fang et al., 2014). After providing informed consent, demographic data and a nickname, subjects are asked to interact with the assigned THCB for approximately ten minutes. For purposes of standardization, pre-defined answer options (e.g. “yes/no”) and a pre-defined conversational decision tree are used similar to the interaction with the Buoy Health service (www.buoyhealth.com/visit/). Data from the subjects are used to personalize THCB interactions. For example, a subject’s nickname is used in the chat while her age is used to dynamically set the age and visual representation of the *peer-like* THCB design. We have already built an open source chat client for Android and iOS including a server infrastructure for that purpose, called MobileCoach (www.mobile-coach.eu) (Filler et al., 2015; Kowatsch et al., 2017). The app is integrated into the web-based survey with the appetize.io service. Thus, subjects do not have to download and install the app but can just focus on the interaction on a computer screen and fill out the survey. We use our own chat app for this study because it allows us to implement the THCB designs and the dialog protocols in a structured XML format that can be adopted, revised and easily communicated (Gregor and Hevner, 2013). The THCBs including dialog templates of the study will be made open source for replication purposes, too. Finally, subjects will be asked to fill out an online questionnaire as described in the following paragraph and get a monetary compensation for their participation.

Perceived interpersonal closeness will be measured with the Inclusion-of-the-Other-in-the-Self (IOS) Scale (Aron et al., 1992), an established and reliable instrument to measure the subjectively perceived closeness of a relationship (Gächter et al., 2015). The Perceived Interpersonal Closeness Scale (PICS), a single-item pictorial scale (Popovic et al., 2003), will be used, too. To assess attachment bond, we adopt the bond subscale of the Working Alliance Inventory for Technology-Based Interventions (Kiluk et al., 2014). Additionally, we will use the instrument of (Bickmore et al., 2005) to assess the desire to continue interacting with the THCB and we ask subjects whether they would like to be part of a study in which they would have the chance to interact with the THCB to benefit from a specific health intervention (e.g. smoking cessation, personality change intervention, etc.). To assess the experience with chat applications we use the instrument of Venkatesh et al. (2012). In an explorative fashion, we are interested in additional qualitative feedback. We thus ask subjects how they would improve the chatbots.

A total of 200 subjects will be recruited. This allows us to find a medium effect between groups ($f=.25$; using G*Power³, ANOVA, fixed effects, omnibus, one-way) at the .05 level of significance and a power of .80, which is an expected effect compared to similar studies (Bickmore et al., 2005; Sah and Peng, 2015). Descriptive statistics and t-tests will be reported for each of the four experimental conditions and each instrument to assess whether the constructs differ significantly from their neutral scale value. Analysis of variance and post hoc tests will be conducted to assess whether there are any substantial and significant differences between the experimental groups with respect to working alliance and the other instruments.

5 Future Work

To empirically assess the research model and hypotheses of this work-in-progress and thus, to answer our research questions, we will next conduct the online experiment with the four THCB designs as introduced in the last section. The THCB with the strongest effect on attachment bond will then be evaluated in a field study with healthy subjects and a focus on all three dimensions of working alliance (i.e. attachment bond, goal agreement and task agreement) and treatment success. The findings will be finally cross-validated with real patients targeting chronic diseases such as asthma and diabetes.

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